COSEWIC
Assessment and Status Report

on the

Behr's Hairstreak
Satyrium behrii

in Canada

ENDANGERED
2012

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2012. COSEWIC assessment and status report on the Behr's Hairstreak *Satyrium behrii* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 48 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Previous report(s):

COSEWIC. 2000. COSEWIC assessment and update status report on the Behr's (Columbia) Hairstreak *Satyrium behrii columbia* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. iv + 9 pp.

Production note:
COSEWIC would like to acknowledge Jennifer Heron for writing the-status report on the Behr's Hairstreak *Satyrium behrii* in Canada, prepared under contract with Environment Canada. This report was overseen and edited by Laurence Packer, Co-chair of the COSEWIC Arthropods Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le Porte-queue de Behr (*Satyrium behrii*) au Canada.

Cover illustration/photo:
Behr's Hairstreak — Photo credit: Adult Behr's Hairstreak, ventral view. Inkaneep Provincial Park, B.C. June 16, 2009. Photo taken by Jennifer Heron.

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Catalogue No. CW69-14/216-2012E-PDF
ISBN 978-1-100-20699-8

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – May 2012

Common name
Behr's Hairstreak

Scientific name
Satyrium behrii

Status
Endangered

Reason for designation
This small butterfly is restricted to antelope-brush habitat in British Columbia, a habitat that has decreased considerably in extent in the past century and remains under threat due to land use change (conversion to viticulture, residential and commercial development) and the impact of fire. It rarely disperses much more than 120 m and persists in small, isolated fragments of habitat, which continue to decline in area and quality. Large annual fluctuations in population size, as documented for the largest Canadian population, increase the species' vulnerability and call into question its long-term viability.

Occurrence
British Columbia

Status history
Designated Threatened in November 2000. Status re-examined and designated Endangered in May 2012.

COSEWIC
Executive Summary

Behr's Hairstreak
Satyrium behrii

Wildlife Species Description and Significance

Behr's Hairstreak (*Satyrium behrii*) is a small butterfly (wingspan 2.5 – 2.9 cm) in the family Lycaenidae. The dorsal forewing and hindwing surfaces have wide black margins that surround a rich, yellowish-orange-brown patch. There is one subspecies of Behr's Hairstreak in Canada.

The larval host plant of Behr's Hairstreak is Antelope-brush, which has special significance in Canada as a symbol used by conservation organizations for the protection of associated plant communities and grasslands within the Okanagan region. First Nations peoples within the region hold butterflies (in general) and the Antelope-brush plant significant in their cultures. Antelope-brush is also significant to the wild game management and livestock grazing industry sectors.

Distribution

The Canadian range of Behr's Hairstreak is restricted to south-central British Columbia from Penticton in the north to Osoyoos in the south. The butterfly inhabits the low elevation (280 – 760 m above sea level) Antelope-brush plant communities on both the east and west side of the south Okanagan Valley. The species occupies an area of less than 12 km^2.

Habitat

Behr's Hairstreak is primarily recorded from the Antelope-brush/Needle-and-thread Grass plant community. Important habitat attributes include plant communities with Antelope-brush plants greater than 30 years old; sparse tree cover (particularly Ponderosa Pine, which may be required by adults for shelter during inclement weather, daytime temperature extremes, and nighttime resting); and the presence of puddling sites (mud puddles where adult butterflies obtain moisture and salt).

Biology

Behr's Hairstreak has one generation per year; the flight period is from mid-May through late July and peaks in mid-June. Eggs are laid singly on the leaves and branches of Antelope-brush where they overwinter. The eggs hatch in early spring, and the larvae develop from late March to late May and pupate in late spring. The pupae are attached to stems of Antelope-brush and this stage lasts approximately two weeks. Behr's Hairstreak is not known to migrate. Adults appear to have limited dispersal capabilities and remain within close proximity to Antelope-brush habitat. Average dispersal distances for the butterfly, based on field studies completed in the south Okanagan Valley, are 80 – 120 m depending on spring weather, with a maximum-recorded dispersal of 1.2 km.

Population Sizes and Trends

Analyses suggest that even the largest known population is unlikely to be sustainable in the long term and extant populations are fragmented, separated by areas of unsuitable habitat that are mostly beyond the species' dispersal capacities.

Habitat trend information shows Antelope-brush plant communities have declined significantly in quantity and quality in the past 200 years. The most recent mapping (2009) shows 3217 ha of Antelope-brush/Needle-and-thread Grass plant community remaining in the south Okanagan, which is approximately one third of its historic distribution (as of 1800).

Threats and Limiting Factors

Behr's Hairstreak faces many threats, most of them associated with habitat conversion and associated fragmentation. The main limiting factor for Behr's Hairstreak is the availability of high quality and older age-class Antelope-brush host plants. Adult butterflies are also limited by nectar plant availability due to short proboscis (tongue) length, which cannot reach the nectar in flowers of plant species that have a deep corolla.

Protection, Status, and Ranks

Behr's Hairstreak is protected under the federal *Species at Risk Act*, *Canada Wildlife Act*, British Columbia *Park Act*, and *Ecological Reserves Act*. The butterfly is recommended for listing as Identified Wildlife under the British Columbia *Forest and Range Practices Act*, *Wildlife Act*, and *Wildlife Amendment Act*.

Behr's Hairstreak (*columbia* subspecies) has a global heritage rank of G5T4T5 (secure), national rank of N1N2 (critically imperiled/imperiled), provincial rank of S1 (imperiled) and is a priority under the British Columbia Conservation Framework. Conservation lands (private and public) protect 15% of existing Antelope-brush habitat in B.C.

TECHNICAL SUMMARY

Satyrium behrii
Behr's Hairstreak — Porte-queue de Behr
Range of occurrence in Canada: British Columbia

Demographic Information

Generation time	1 year to complete life cycle
Is there an inferred continuing decline in number of mature individuals?	Yes; based on habitat loss and records at Vaseux study area over a four-year period (2004 – 2008)
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown; variable rate of reduction predicted, based on recent history of habitat loss
Estimated percent reduction in total number of mature individuals over the last 10 years	Unknown; variable rate of reduction predicted, based on recent history of habitat loss
Projected percent reduction in total number of mature individuals over the next 10 years	Unknown; variable rate of reduction predicted, based on recent history of habitat loss
Inferred percent reduction in total number of mature individuals over any 10 years period, over a time period including both the past and the future.	Unknown; variable rate of reduction predicted, based on recent history of habitat loss
Are the causes of the decline clearly reversible and understood and ceased?	No, not reversible because of land conversion. Yes, causes of decline are understood (habitat loss). No, causes of decline have not ceased.
Are there extreme fluctuations in number of mature individuals?	Considerable fluctuation, but not of an order of magnitude

Extent and Occupancy Information

Estimated extent of occurrence	353 km² in Canada
Index of area of occupancy (IAO) using a 2 x 2 km^2 grid	IAO 184 km^2 (Figure 8) Biological AO 11.4 km^2 (1142.98 ha)

Is the total population severely fragmented?	Yes, the largest population is unlikely to be sustainable in the long term; the butterfly is loathe to fly over unsuitable habitat or over areas where the larval foodplant is not found and patches of this plant are separated by inhospitable agricultural land, urban developments, roads and rivers.
Number of "locations*"	32; fragmented habitat on the west side of the valley; east side of valley has high threat of habitat conversion
Is there a projected continuing decline in extent of occurrence?	Yes; based on habitat loss and threats; 1995 (4376 ha) to 2008 (3217 ha), 1159 ha or 26% reduction in habitat area.
Is there a projected continuing decline in index of area of occupancy?	Yes, based on habitat loss and threats (see above)
Is there a projected continuing decline in number of populations?	Yes, based on habitat loss and threats (see above)
Is there a projected continuing decline in number of locations?	Yes, based on habitat loss and threats (see above)
Is there a projected continuing decline in area, extent and/or quality of habitat?	Yes, based upon threats. Note also the past decline in many of the aforementioned parameters as outlined in the text.
Are there extreme fluctuations in number of populations?	Not known for sure but seems not very probable given current understanding
Are there extreme fluctuations in number of locations*?	Not known for sure but seems not very probable given current understanding
Are there extreme fluctuations in extent of occurrence?	Not known for sure but seems not very probable given current understanding
Are there extreme fluctuations in index of area of occupancy?	Not known for sure but seems not very probable given current understanding

Number of Mature Individuals (in each population)

Population	N Mature Individuals
All locations	unknown
Largest population peaked at less than 3300 individuals	
Total	unknown

* See definition of location.

Quantitative Analysis

Not performed	

Threats (actual or imminent, to populations or habitats)

There are three main threats. 1) Residential, urban and commercial development. 2) Conversion of habitat to viticulture. 3) Fire and fire suppression.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)?	
Is immigration known or possible?	Natural immigration is unlikely
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Maybe
Is rescue from outside populations likely?	Unlikely

Current Status

COSEWIC: Designated Threatened in November 2000. Status re-examined and designated Endangered in May 2012.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)

Reasons for designation:

This small butterfly is restricted to antelope-brush habitat in British Columbia, a habitat that has decreased considerably in extent in the past century and remains under threat due to land use change (conversion to viticulture, residential and commercial development) and the impact of fire. It rarely disperses much more than 120 m and persists in small, isolated fragments of habitat, which continue to decline in area and quality. Large annual fluctuations in population size, as documented for the largest Canadian population, increase the species' vulnerability and call into question its long-term viability.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v). The EO and IAO are both below thresholds, the species is considered severely fragmented because it occurs in isolated habitat fragments and rarely flies any distance over unsuitable habitat, and declines in EO, IAO, area and quality of habitat, number of locations, and number of individuals have been extensive in the past and are continuing.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Population size unknown but thought to be above threshold for Endangered.
Criterion D (Very Small or Restricted Total Population): Not applicable. Population size unknown but certainly above threshold for Endangered
Criterion E (Quantitative Analyses): Not performed.

PREFACE

Behr's Hairstreak was previously assessed by COSEWIC in 2000 as threatened. Since the first status report was prepared, substantial new information on the distribution, habitat information, habitat trends, and threats and limiting factors has been gained through inventory and research by numerous private entomologists, academic researchers, government biologists and stewardship groups working within the southern Okanagan Valley

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2012)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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Behr's Hairstreak

Satyrium behrii

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Scientific Name: *Satyrium behrii*

Classification:
Order Lepidoptera
Family Lycaenidae
Subfamily Theclinae
Genus *Satyrium*
Species *S. behrii* (W.H. Edwards 1870)

Taxonomic Synonyms: *Callipsyche behrii* (Edwards); *Thecla Behri* Edwards.

Type Specimens: The type locality of the species is "Lake Mono, California" [Mono County]. For details on subspecies see "Taxonomic Background" below.

English Names: Behr's Hairstreak, Columbia Hairstreak. Both English names are proposed in Layberry *et al.* (1998); the former refers to the entire species, and the latter to subspecies *columbia*. Columbia Behr's Hairstreak is used in The International Lepidoptera Survey (TILS) (2009) and refers to subspecies *columbia*. However, subspecies status of this form is unresolved.

French Name: Porte-queue de Behr.

Taxonomic Background and Similarities: The taxonomy of Behr's Hairstreak subspecies is in question (Warren, 2005). However, as there is only one subspecies of *S. behrii* in Canada, usage of the species' name is unambiguous when applied to Canadian examples of the butterfly in this report.

Morphological Description

The following morphological description refers to Canadian *Satyrium behrii*.

Adults

Behr's Hairstreak is a small butterfly (wingspan 2.5 – 2.9 cm), distinguished from other butterfly species within its Canadian range by its unique wing pattern (Layberry *et al.* 1998; Guppy and Shepard 2001). The dorsal surfaces of both the forewings and hindwings have wide black margins surrounding a rich, orange-brown patch (Figure 1). The inner, thoracic edge of the dark margin is indistinct. The ventral surfaces of the forewings and hindwings have a greyish brown base colour, darker near the thorax, and the outer wing margins have a series of prominent dark spots surrounded by white borders (Figure 2) (Layberry *et al.* 1998; Guppy and Shepard 2001). These spots are more frequent and pronounced on the hindwings. The marginal line on the wing underside is black, bordered by a sub-marginal white line, and the wing fringe is grey

(Layberry *et al.* 1998; Guppy and Shepard 2001). The sexes are similar, although when compared side-by-side, males are an overall darker tawny-orange and have distinct dark scent patches on the forewings. Behr's Hairstreak hindwings are tailless (Layberry *et al.* 1998; Guppy and Shepard 2001).

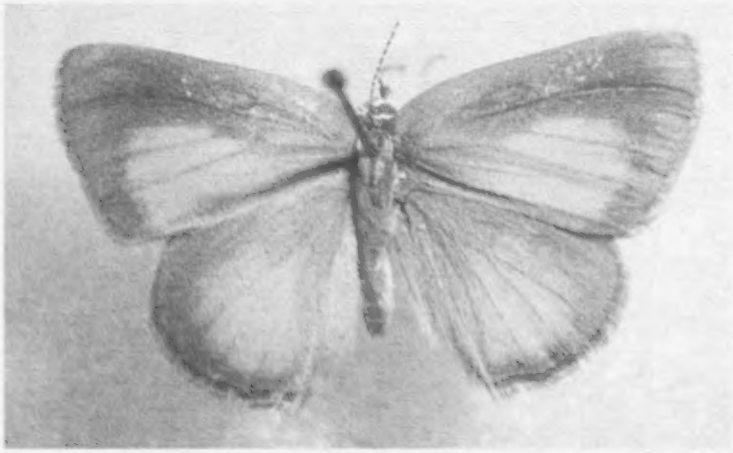


Figure 1. Adult Behr's Hairstreak, dorsal view. Specimen housed at Beaty Biodiversity Museum, Spencer Entomological Collection, University of British Columbia. Photo Jennifer Heron.

Figure 2. Adult Behr's Hairstreak, ventral view. Inkaneep Provincial Park, B.C. June 16, 2009. Photo Jennifer Heron.

When compared with other Behr's Hairstreak subspecies, adults of subspecies *columbia* have larger black spots and a darker underside (Layberry et al. 1998).

Eggs

Behr's Hairstreak eggs are greenish white, slightly oval, and laid singly on leaves and branches of the larval host plant, Antelope-brush (*Purshia tridentata*) (Comstock, 1928; Emmel and Emmel 1973). There are no photographs of Behr's Hairstreak eggs from B.C.

Larvae

Mature Behr's Hairstreak larvae are green, 1 – 1.5 cm long, have a white line on the dorsal surface, and are darker green on the sides of the body (Figure 3) (Comstock 1928; Miller 1995; Guppy and Shepard 2001; S. Desjardins pers. comm. 2009). Larvae are ridged dorsally and pale yellow or white shading or streaking may also occur on the crest of the abdominal segments. Hairstreaks (in general) typically have four or five larval development stages (instars) prior to pupation (Kitching *et al.* 1999), each larval stage looking similar to the last.

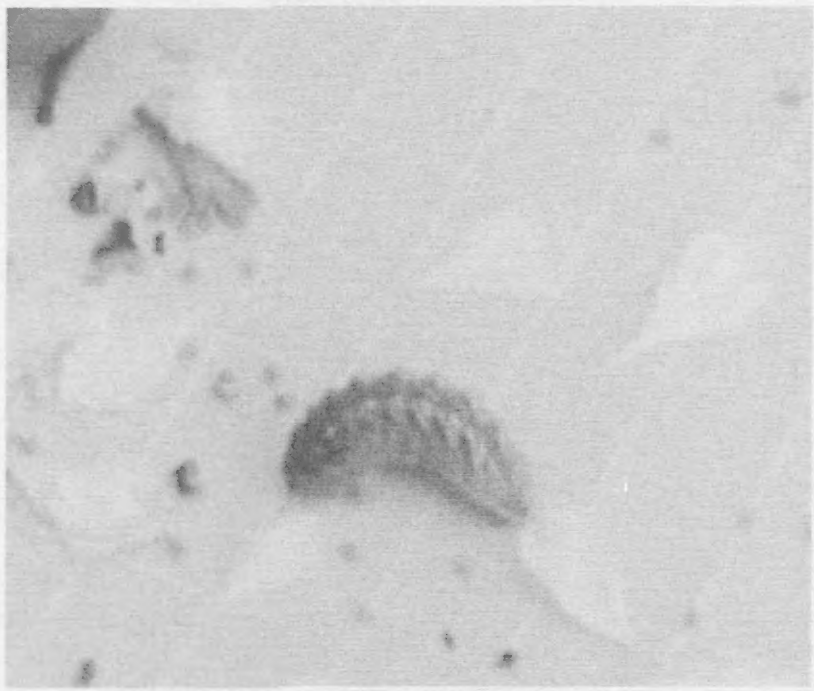


Figure 3. Behr's Hairstreak larva, Kennedy Property outside Oliver, B.C. May 2007. Photo Sylvie Desjardins. Reproduced with permission.

Pupae

Behr's Hairstreak pupae are light brown with dark brown speckles or patches. Larvae attach to the host plant stem using a silk patch before pupating (Comstock 1928). There are no photographs of Behr's Hairstreak pupae from B.C., but a pupa from California is illustrated by Guppy and Sheppard (2001).

Genetic Description

No barcode sequences of *S. behrii* are currently publicly available (Biodiversity Institute of Ontario 2011).

It has been demonstrated that amplified fragment length polymorphism (AFLP) data can be obtained from small sections of the wings of Behr's Hairstreak (Keyghobadi *et al.* 2009).

Population Spatial Structure and Variability

Behr's Hairstreak dispersal capabilities are limited (see **Dispersal and Migration)** and recolonization after extirpation is poorly known. The area of Antelope-brush (and other habitat components) necessary to sustain a long-term viable population is unknown. The butterfly likely forms a metapopulation structure among numerous Antelope-brush habitat patches and in some years may use only a portion of an apparently suitable Antelope-brush patch (D. St. John pers. comm. 2009; S. Desjardins pers. comm. 2009) (see **Habitat Requirements** and **Dispersal and Migration**).

Designatable Units

Behr's Hairstreak has one designatable unit within Canada (see **Distribution**).

Special Significance

Behr's Hairstreak is used by numerous conservation organizations (e.g., Nk'Mip Desert Cultural Centre 2009; Osoyoos Desert Centre 2009; South Okanagan Similkameen Conservation Program 2009) to represent the importance of Antelope-brush plant communities and grasslands within the south Okanagan. In addition, conservation organizations such as the South Okanagan Similkameen Conservation Program (B. White pers. comm. 2009) and The Land Conservancy (A. Skinner pers. comm. 2009) use Behr's Hairstreak as an iconic butterfly species when informing private landowners about stewardship opportunities.

The Antelope-brush plant community with which the butterfly is associated has cultural significance to First Nations people within the south Okanagan (J. Armstrong to O. Dyer pers. comm. 2009; Dreyer 1978 and Peters *et al.*, 2003 as cited in Adams and Garcia 2005; Netz *et al.*, 1940 and Train *et al.* 1941 as cited in Young and Clements 2002). The Syilx First People use Behr's Hairstreak as a marker to find certain nutritious plants (Okanagan First People 2010).

Antelope-brush plant communities and related grasslands are important to numerous industry sectors within the Okanagan region. Management of Antelope-brush for wild game forage has been ongoing for the past century; the plant is of nutritive importance to native Mule Deer (*Odocoileus hemionus*) and Bighorn Sheep (*Ovis canadensis*) (Krannitz and Hicks 2000) (see **Interspecific Interactions**). The use of Antelope-brush grasslands for ranching and domestic livestock grazing has been ongoing for the past 150 years (see **THREATS AND LIMITING FACTORS**). Range management has at times conflicted with native ungulate management objectives, both in the Okanagan and in more southerly parts of the ecosystem's range in the United States (Young and Clements 2002). Antelope-brush plant communities are also used as a correlate of potentially high grape crop production and thus are targeted by the wine industry for development and conversion to vineyards (Dyer pers. comm., 2009; B. White pers. comm. 2009) (see **THREATS AND LIMITING FACTORS**).

DISTRIBUTION

Global Range

Satyrium behrii's global range extends from southern B.C., through the Pacific states of the USA eastwards to the extreme NW of Texas and Colorado (Figure 4).

Figure 4. Global range of Behr's Hairstreak (*Satyrium behrii*) (Opler *et al.*, 2010). Dotted line represents the potential range limit of Behr's Hairstreak (*S. b. columbia*) although subspecies-level taxonomy of the butterfly remains uncertain.

Definitive geographic boundaries among the subspecies (see **Name and Classification**) in North America are unclear. *Satyrium b. behrii*, the nominate subspecies, occurs on the east slope of the Sierra Nevada, north to at least central Oregon (Warren 2005) and possibly north to central Washington state (Pelham, 2011). *Satyrium b. columbia* is suggested to occur from Chelan County Washington northwards into Canada. If these two subspecies are synonymous (Warren 2005), these two ranges would be combined as the range of *S. b. behrii*. *Satyrium b. crossii* (Cross's Hairstreak) is found in Colorado, Arizona and New Mexico (Cary and Holland 1992); and *S. b. kali* occurs in Arizona and southern Nevada. The species (as a whole) occurs outside of the range of Antelope-brush (Figure 4), suggesting an alternate larval host plant is probable, although no further information is available. Opler and Wright (1999) give Mountain Mahogany (*Cercocarpus sp.*) as a host plant, although this species is not known to occur within the range of Behr's Hairstreak in Canada nor is it tracked by the B.C. Conservation Data Centre (2011).

Canadian Range

The Canadian range of Behr's Hairstreak is restricted to the south Okanagan Valley, B.C. (Figure 5) and the butterfly has been recorded from both sides of the Okanagan valley from Penticton (northernmost record) to Osoyoos (southernmost record) (Figure 6). The butterfly's range is associated with the Antelope-brush plant communities (Figure 7) primarily at elevations below 760 m on both the east- and west-facing slopes of the Okanagan Valley (Lloyd *et al.* 2000). Less than 1% of the global distribution of Behr's Hairstreak is within Canada.

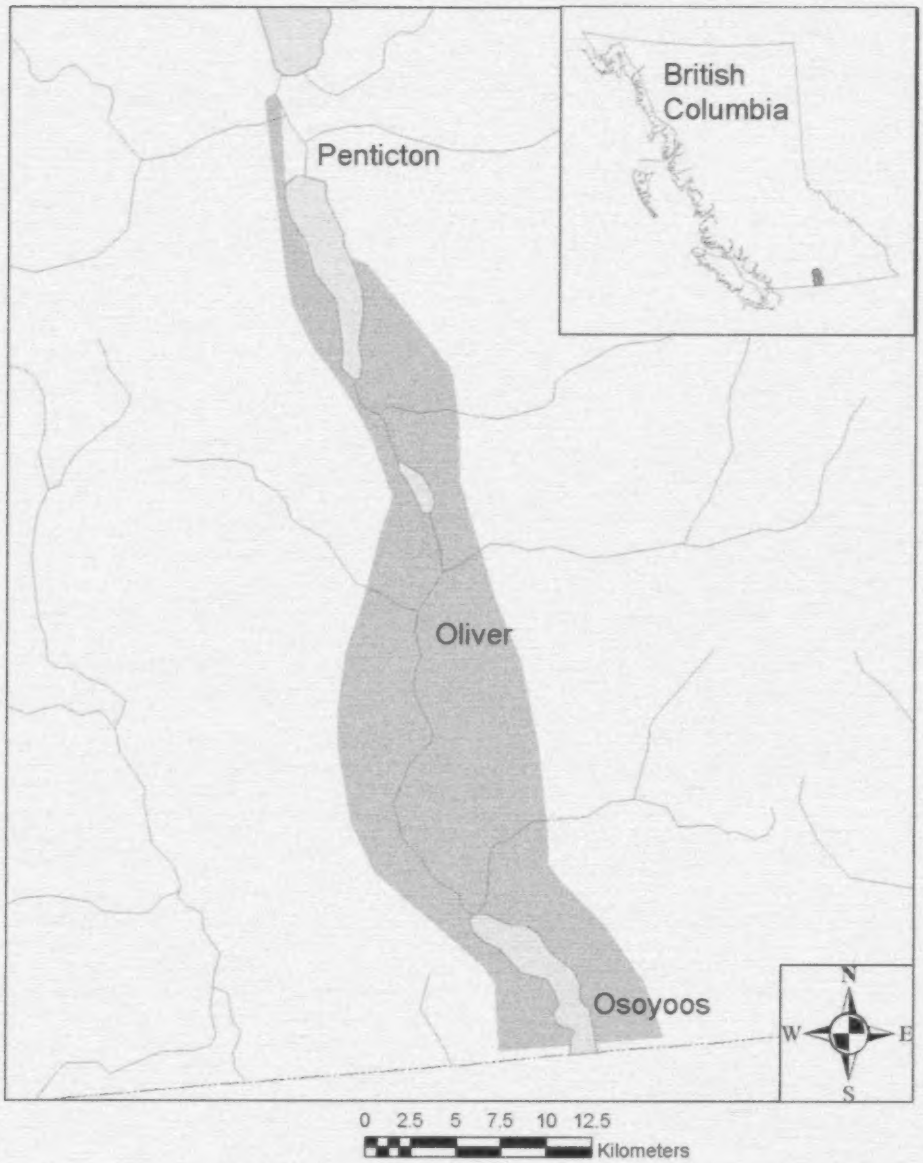


Figure 5. Canadian range of Behr's Hairstreak. Map by Orville Dyer. Reproduced with permission.

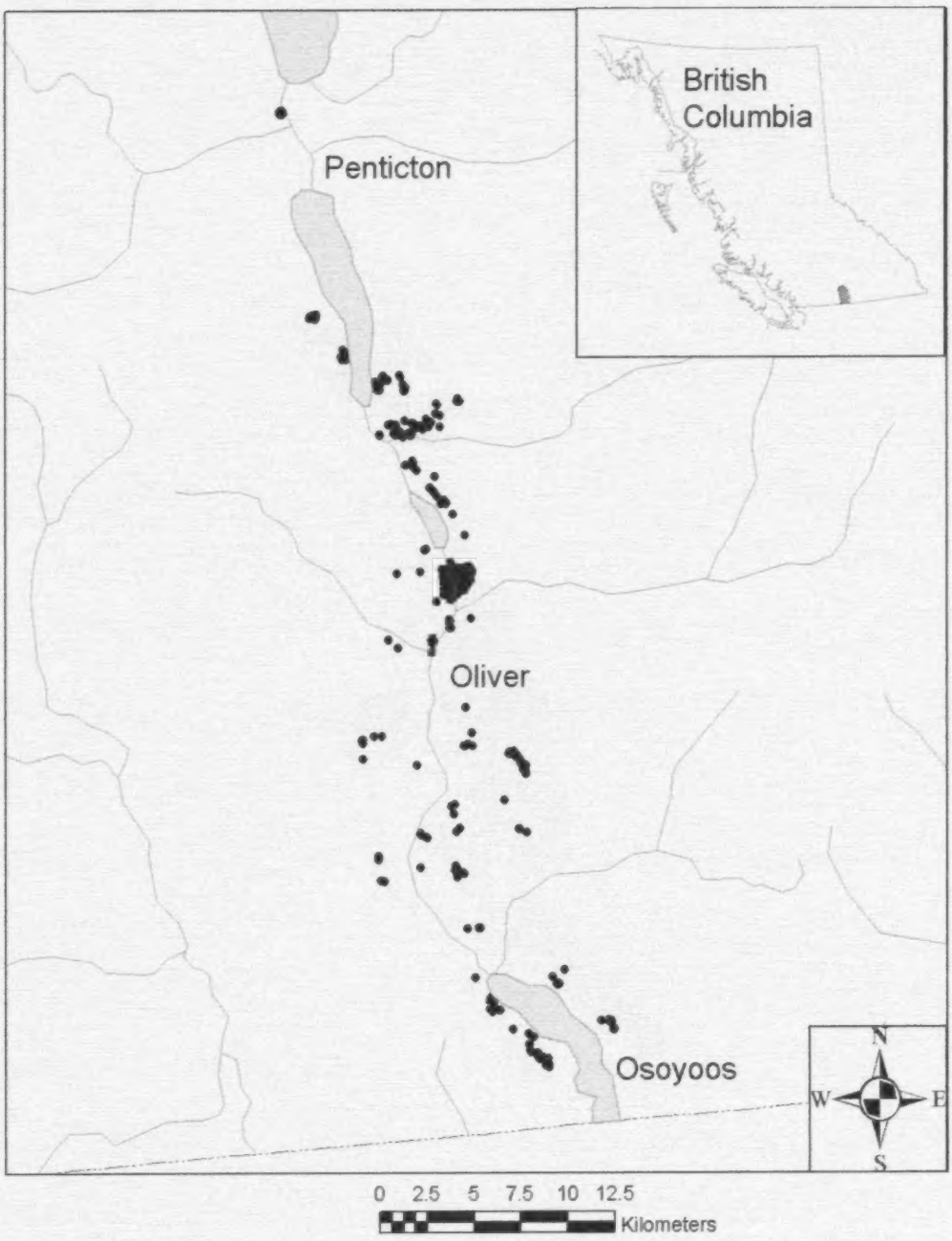


Figure 6. Behr's Hairstreak records (black dots) (1995 – 2009) overlaid with the most recent Antelope-brush habitat mapping (2005). Map by Orville Dyer. Reproduced with permission. Yellow shading represents habitat classified as Very Hot Dry Bunchgrass, BGxh1 (B.C. Ministry of Forests, 2009).

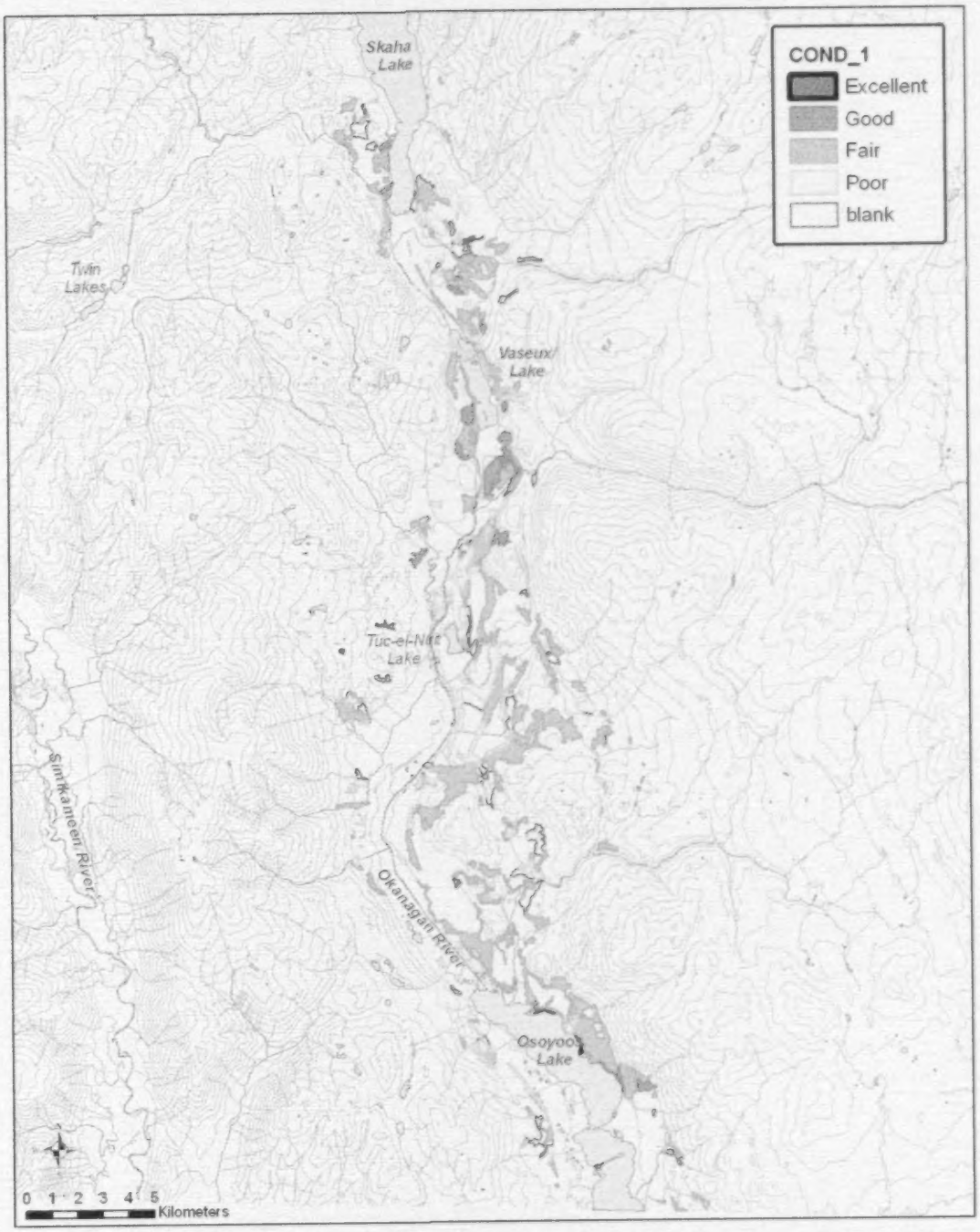


Figure 7. Ecological condition of Antelope-brush - Needle-and-thread Grass habitat within B.C. as of 2008. As cited in Iverson (2010). Note that this map concerns habitat and not the distribution of larval hostplant *per se*.

The extent of occurrence for Behr's Hairstreak is calculated from terrestrial ecosystem mapping (using occurrence records from 1995 to present) and estimated at 353 km^2. The index of area of occupancy (IAO) for Behr's Hairstreak is 184 km^2 based on a 2km X 2km grid overlay (as in Figure 8). The biological area of occupancy (BAO) of Behr's Hairstreak is estimated at 11.4 km^2 (1142.98 ha). The BAO area was estimated (using terrestrial ecosystem mapping information) by 1) totalling the area of all Antelope-brush polygons containing Behr's Hairstreak records, and 2) multiplying each polygon by the percentage cover of Antelope-brush mapped within that polygon; and 3) summing the area of Antelope-brush among polygons to reach the grand total of biological area of occupancy. The calculation assumes the butterfly's population is evenly distributed throughout the Antelope-brush within each polygon and that sufficient nectar plant resources are within the Antelope-brush patch. It is recognized this calculation is an underestimate of Antelope-brush habitat needed.

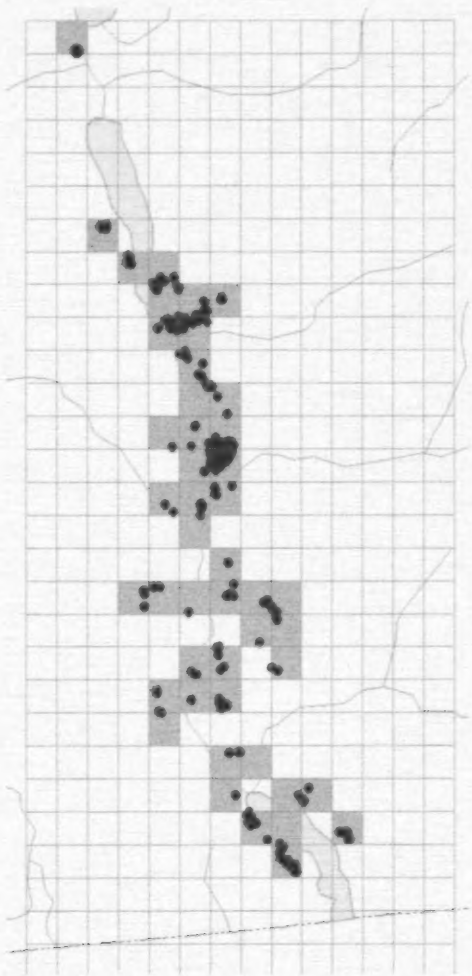


Figure 8. Index of area of occupancy for Behr's Hairstreak, 220 km^2. Each square represents 2 km X 2 km (4 km^2). Black dots represent a Behr's Hairstreak occurrence. Grey background represents a square with Behr's Hairstreak record. Map prepared by Orville Dyer, January 2010.

To define locations (Figure 9), all records were mapped as points and overlaid with the most recent Antelope-brush terrestrial ecosystem mapping information (Iverson *et al.* 2005) (Figure 7). Preliminary mark-recapture results show Behr's Hairstreak is unlikely to disperse across or through areas including large water bodies or lakes (e.g., Okanagan or Skaha Lake), urban settings (e.g. the town or Oliver), agricultural areas (e.g. vineyards or orchards) or larger roadways (S. Desjardins pers. comm. 2009; D. St. John pers. comm. 2009).

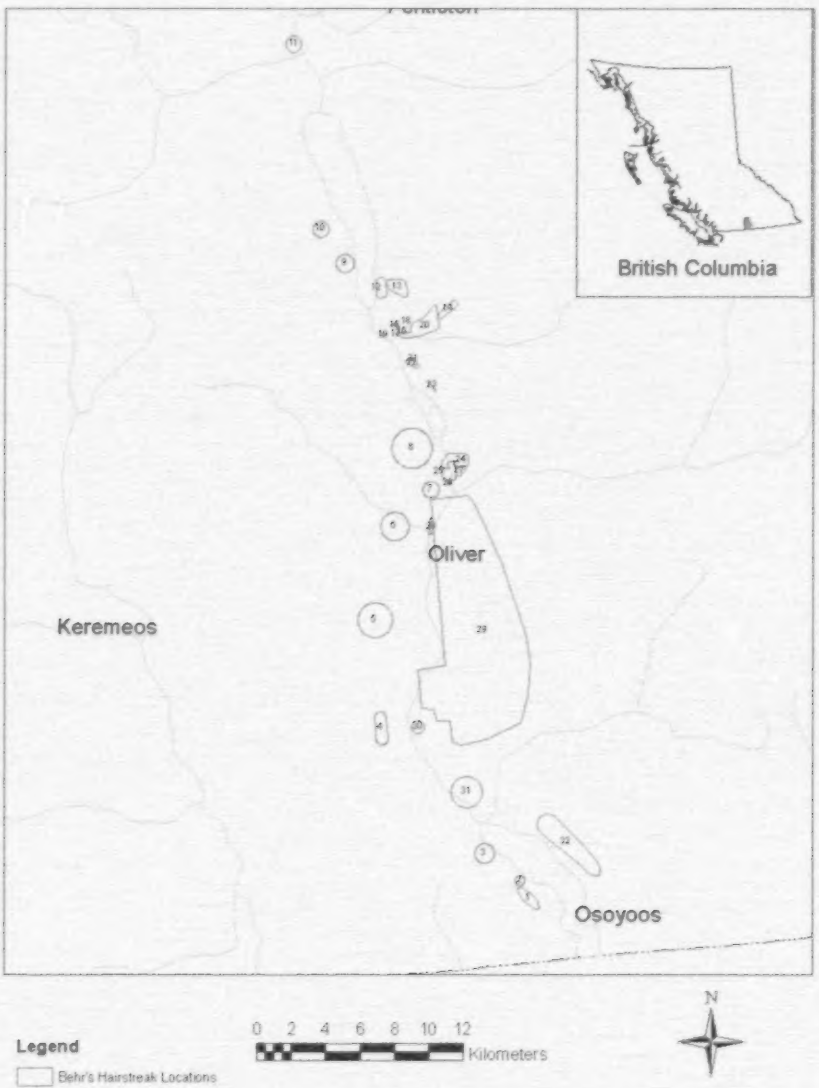


Figure 9. Behr's Hairstreak locations in B.C. Records on Indian Reserves and some private lands are not mapped precisely due to lack of a data sharing agreement. Map by Orville Dyer. Reproduced with permission.

Figure 10. Antelope-brush (*Purshia tridentata*) plant community at Haynes Lease Ecological Reserve, June 1998. Photo Jennifer Heron.

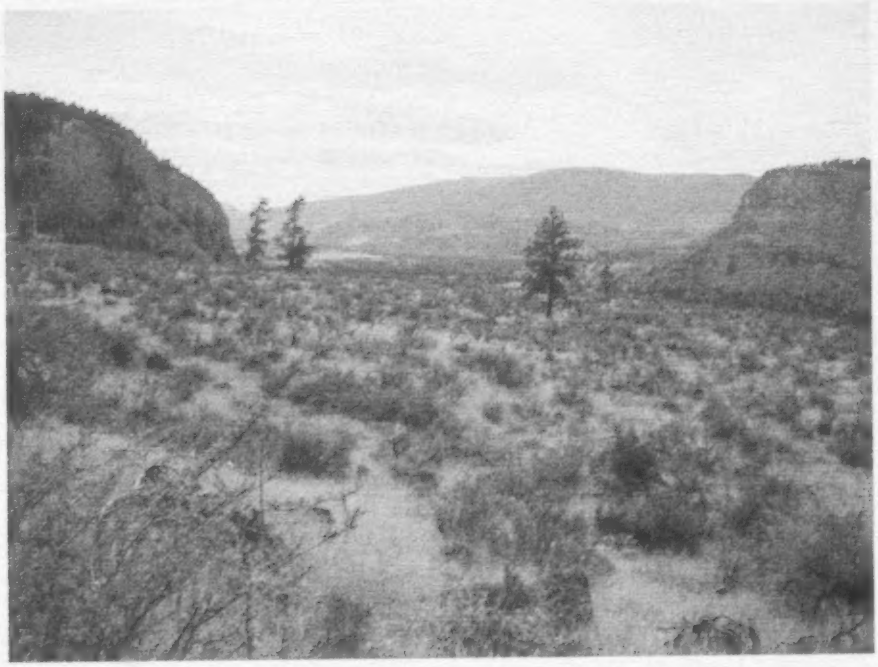


Figure 11. Antelope-brush (*Purshia tridentata*) habitat at The Nature Trust property near Okanagan Falls, July 2009. Photo Jennifer Heron.

The predominant threat to Behr's Hairstreak is habitat loss (see **THREATS AND LIMITING FACTORS**) and if a population is on private land, there is a substantially higher threat of land conversion and habitat loss. The spatial boundaries of most populations span multiple land owners/tenures and only a portion of the land may be subject to habitat conversion (e.g. to vineyards). Using land ownership as the factor determining the level of the habitat loss threat, there are approximately 32 locations for Behr's Hairstreak (Table 1).

Table 1. Behr's Hairstreak locations in B.C.

Location Number (Figure 9)	Land Ownership	Comments on Threats
1	• Private • Municipal (Town of Osoyoos)	• Osoyoos Golf Course (one parcel of property) and Town of Osoyoos (one parcel of property).
2	• B.C. government • municipal (Town of Osoyoos)	• Two separate parcels of habitat, although adjacent to one another. Both are under some form of conservation. • Provincial Crown portion is planned for inclusion in the South Okanagan Wildlife Management Area. • Other property is owned by Town of Osoyoos and is a park/walkway.
3	• B.C. government	• Comprised of three separate units • Osoyoos Desert Centre (protected; leased from the B.C. government) • Field's Lease Ecological Reserve (protected, B.C. government) • Unprotected parcel at present to be sold to Town of Osoyoos for residential development.
4	• B.C. government	• Proposed wildlife reserve, currently unprotected
5	• B.C. government,	• Proposed wildlife reserve, currently unprotected
6	• B.C. government	• Wildlife reserve (protected)
7	• Private	• No information available
8	• B.C. government; federal government (Canadian Wildlife Service)	• Vaseux Lake Bighorn Sheep Reserve (federal) and provincial protected areas (protected)
9 & 10	• Private land and Indian Reserve	• No information available
11	• Indian Reserve	• No information available
12	• Private conservation land	• Owned by The Nature Trust
13	• B.C. government	• Grazing lease to two separate licensees: The Nature Trust with one lease (no grazing) and a private rancher (grazing)
14	• B.C. government	• Non-designated Crown land; unprotected
15	• Private	• No information available
16	• Private	• No information available
17	• Private	• No information available
18	• Private	• No information available
19	• Private	• No information available
20	• Private	• Private conservation land owned by The Nature Trust
21	• Private	• No information available
22	• Private	• Conservation land owned by The Nature Trust
23	• Federal government	• Canadian Wildlife Service

Location Number (Figure 9)	Land Ownership	Comments on Threats
24	• Private	• Conservation land owned by The Nature Trust
25	• Private	• No information available
26	• Private	• Hydro substation (private)
27	• B.C. government and federal government	• Federal Vaseux Lake Bighorn Sheep Reserve • Provincial conservation land
28	• B.C. government	• Inkaneep Provincial Park (protected)
29	• Indian Reserve	• Contains some protected habitat as part of an interpretive centre. • No information available on land use planning
30	• B.C. government	• Part of South Okanagan Wildlife Management Area (protected)
31	• B.C. government	• Part of South Okanagan Wildlife Management Area (protected)
32	• Indian Reserve	• No information available on land use planning

Habitat on the west side of the valley (Figure 9: location numbers 1 to 10) is severely fragmented and has extensive agricultural development separating Antelope-brush habitats (further discussed in **THREATS AND LIMITING FACTORS**). The East Okanagan locations (Figure 9: location numbers 11 to 32) includes one comparatively large area (location 29) which consists of numerous Antelope-brush habitat polygons each within the butterfly's dispersal capabilities. However, this area is separated from the other locations on the east side of the valley and these are also widely separated from each other.

There is a large number of comparatively small populations of this species in Canada. The species fits the COSEWIC definition of severely fragmented when even the largest known population is considered to be unsustainable in the long term.

Search Effort

There has been substantial search effort for Behr's Hairstreak in the past ten years (Table 2, Appendix 1). Search effort methodology has primarily involved wandering transects through potential habitat (see **Habitat Requirements**). Wandering transects follow no predetermined grid or fixed route and allow the surveyor to change course depending on habitat suitability. Wandering transects are an efficient method of determining butterfly presence when little information is available.

Table 2. Summary of inventory (2001 – 2009) for Behr's Hairstreak.

Year	Survey Project/Title	Approximate Search Effort	Reference
2001 - 2003	Biogeography of Behr's Hairstreak	52 survey sites / Antelope-brush polygons* searched; 8095 person minutes (134.9 person hours)	St. John and Bunge 2003
2004	Behr's Blitz	42 survey sites / Antelope-brush polygons searched; two surveyors at each site (minimum). A minimum of 15 minutes was spent searching each site, although the exact survey length was not recorded.	B.C. Conservation Data Centre 2009; B.C. Ministry of Environment, Penticton Office, Behr's Hairstreak database 2009
2005	B.C. Ministry of Environment	Six sites / Antelope-brush polygons searched. Two surveyors (minimum). A minimum of 15 minutes was spent searching each site, although the exact survey length was not recorded.	S. Desjardins pers. comm. 2009; B.C. Conservation Data Centre 2009; B.C. Ministry of Environment, Penticton Office, Behr's Hairstreak database 2009
	University of British Columbia-Okanagan Behr's Hairstreak Mark-recapture Study	Minimum of six sites / Antelope-brush polygons searched. A minimum of 15 minutes was spent searching each site, although the exact survey length was not recorded.	S. Desjardins pers. comm. 2009
2006	University of British Columbia-Okanagan Behr's Hairstreak Mark-recapture Study	Minimum of six sites / Antelope-brush polygons searched. A minimum of 15 minutes was spent searching each site, although the exact survey length was not recorded.	S. Desjardins pers. comm. 2009
2007	B.C. Ministry of Environment staff biologists and B.C. Conservation Corp. Crew	Ten sites / Antelope-brush polygons searched. A minimum of 15 minutes was spent searching each site, although the exact survey length was not recorded.	B.C. Conservation Data Centre 2009; B.C. Ministry of Environment, Penticton Office, Behr's Hairstreak database 2009
	University of British Columbia-Okanagan Behr's Hairstreak Mark-recapture Study	Minimum of six sites / Antelope-brush polygons searched. A minimum of 15 minutes was spent searching each site, although the exact survey length was not recorded.	S. Desjardins pers. comm. 2009
2009	B.C. Ministry of Environment and B.C. Conservation Corp. Crew	Surveys at seven sites / Antelope-brush polygons searched. No information is available on search effort (minutes).	B.C. Conservation Data Centre 2009; B.C. Ministry of Environment, Penticton Office, Behr's Hairstreak database 2009
	University of British Columbia-Okanagan Behr's Hairstreak Mark-recapture Study	Surveys at three sites / Antelope-brush polygons searched. A minimum of 15 minutes was spent searching each site, although the exact survey length was not recorded.	S. Desjardins 2009

* polygon refers to a unit of Antelope-brush habitat that has been delineated spatially by terrestrial ecosystem mapping

During surveys where Behr's Hairstreak was observed, the occurrence was recorded using a hand-held GPS (geographic positioning system) unit. All records were then mapped using ARCVIEW software applications. Null data were also collected; the occasional absence of the butterfly is therefore not fully represented in Figures 6-9. Intensive mark-recapture surveys have been ongoing since 2004 in the Vaseux Lake area (large black area of combined dots on Figure 8) (Desjardins pers. comm. 2009).

HABITAT

Habitat Requirements

Behr's Hairstreak depends on Antelope-brush as its larval host plant to complete its life cycle. Antelope-brush plant communities primarily occur in the low elevation valley bottoms (280 – 760 metres elevation above sea level, Iverson 2010). In reference to an ecosystem classification system developed by the B.C. Ministry of Forests (2009), the species occupies xeric sites of the driest variant of the Bunchgrass (BG) Biogeoclimatic Zone BGxh1 (Very Hot Dry Bunchgrass) (yellow areas in Figure 7). Some Antelope-brush plant communities also occur at the margins of the Ponderosa Pine (PP) Biogeoclimatic zone PP: PPxh1subzone (Very Hot Dry Ponderosa Pine) (B.C. Ministry of Forests 2009).

Plant communities that contain Antelope-brush as a dominant component and where Behr's Hairstreak has primarily been recorded include 1) Antelope-brush/Needle-and-thread Grass (*Purshia tridentata/Hesperostipa comata*) (78.6% of observations); 2) Pine/Antelope-brush (*Pinus ponderosa/Purshia tridentata*) (17.6% of observations) and 3) Wheatgrass/Selaginella (*Agropyron spicatum-Selaginalla densa*) (0.2% of observations) (Table 3).

Table 3. Number of Behr's Hairstreak records within different plant community types (B.C. Conservation Data Centre 2009; B.C. Ministry of Environment, Penticton Office, Behr's Hairstreak database 2009).

Plant community type	Number of individual Behr's Hairstreak observed (1995 to 2009)	Percentage of total Behr's Hairstreak observations in plant community type
Antelope-Brush/Needle-and-thread Grass (*Purshia tridentata /Hesperostipa comata*)	3607	78.6
Pine/Antelope-brush (*Pinus ponderosa/Purshia tridentata*)	810	17.6
Wheatgrass/Selaginella (*Agropyron spicatum/Selaginalla densa*)	9	0.2
Behr's Hairstreak records in plant communities that contain Antelope-brush but where Antelope-brush is not the representative shrub type for the plant community	29	0.8
Behr's Hairstreak records in plant communities that are not currently mapped as containing Antelope-brush (e.g., including some polygons that have been destroyed by development but historically had Antelope-brush; road right of ways; have a minor component of Antelope-brush that is not mappable; may be GPS or mapping errors; etc.)	128	2.8
Total	4583	100

Note these percentages are slightly biased based on survey intensity at some sites, and biased toward habitats containing Antelope-brush. The information presented here is meant to indicate trends.

Habitat mapping in 2009 of the Antelope-brush/Needle-and-thread Grass plant habitat in the south Okanagan estimates the extent of occurrence of the plant community at 204 – 254 km^2 with the area of occupancy (not the IAO) as 32.17 km^2. However, although there are 21 sites where the plant community occurs, only four are considered to have good ecological integrity (Iverson 2010; Figure 7). The four areas with the best habitat are on Osoyoos Indian Band lands and have not been searched for the butterfly recently. The exact locations of the old records on these properties are unknown.

The Antelope-brush/Needle-and-thread Grass plant community has a shrub layer consisting of 10 – 30% cover of Antelope-brush, with lesser amounts of Big Sagebrush (*Artemisia tridentata*) and Rabbit-brush (*Ericameria nauseosus* var. *speciosa*). The herb layer is variable but is typically dominated by Needle-and-thread Grass (*Hesperostipa comata*), with Brittle Prickly-pear Cactus (*Opuntia fragilis*) and Sand Dropseed (*Sporobolus cryptandrus*). The moss layer may contain a low percent cover of Sidewalk Moss (*Tortula ruralis*). At climax, this plant community is expected to have a moderate cover of two grasses: Bluebunch Wheatgrass (*Pseudoroegneria spicata*) and Junegrass (*Koeleria macrantha*) (Lloyd *et al.* 2000) and the cryptogam crust should consist of a variety of lichen and moss species, be well developed, and provide moderate to continuous ground cover. Behr's Hairstreak predominantly occurs in the Antelope-brush/Needle-and-thread Grass plant community. Further information on Antelope-brush plant communities in the Okanagan can be found in Lloyd *et al.* (2000) and Dyer and Lea (2003).

Behr's Hairstreak adults obtain nectar from a variety of native and non-native (as determined by Pojar and McKinnon, 1994) flowering plants, including Yarrow (*Achillea millefolium*) (Figure 12) (it is disputed whether this plant is native or non-native), Baby's Breath (*Gypsophila paniculata*) (non-native) (Figure 13), Smooth Sumac (*Rhus glabra*) (native) (Figure 14), Grey Horsebrush (*Tetradymia canescens*) (native) (Figure 15), Sweet-clover (*Melilotus* spp.) (non-native), Oceanspray (*Holodiscus discolor*) (native), and various buckwheat species (*Eriogonum* spp.) (native) (Pyle 2002; St. John and Bunge 2003; D. St. John pers. comm. 2009). Field observations document Yarrow as the most important nectar source in B.C. due to its widespread prevalence in Antelope-brush plant communities and its prolonged flowering season (St. John and Bunge 2003; D. St. John pers. comm. 2009; B.C. Conservation Data Centre 2009). Behr's Hairstreak may use patches of Yarrow as mating sites (St. John and Bunge 2003; D. St. John pers. comm. 2009; S. Desjardins pers. comm. 2009).

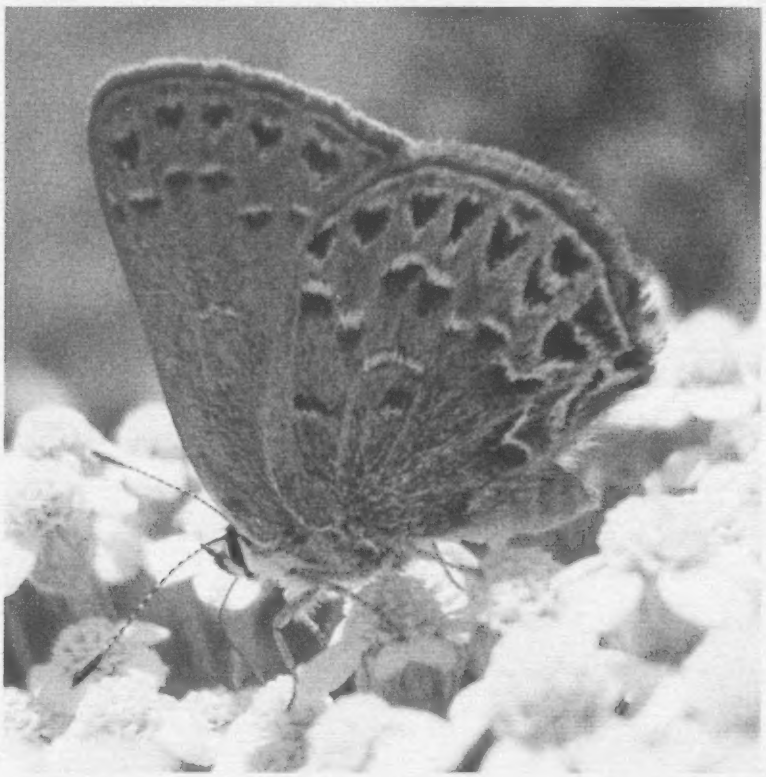


Figure 12. Behr's Hairstreak nectaring on Yarrow (*Achillea millefolium*). Photo Jennifer Heron.

Figure 13. Baby's Breath (*Gypsophila paniculata*), Haynes Lease Ecological Reserve, June 2009. Photo Jennifer Heron.

Figure 14. Smooth Sumac (*Rhus glabra*) at Haynes Lease Ecological Reserve, June 2009. Photo Jennifer Heron.

Figure 15. Behr's Hairstreak nectaring on Grey Horsebrush (*Tetradymia canescens*). The Nature Trust property, June 2009. Photo Jennifer Heron.

Correlations drawn from inventory data and observations suggest that plant communities with Antelope-brush plants more than 30 years old may be more important for Behr's Hairstreak than early-successional stage Antelope-brush plant communities (S. Desjardins pers. comm. 2005 – 2009; D. St. John pers. comm. 2005 – 2009). Differences in the plant chemistry of Antelope-brush at certain ages (e.g., concentration of compounds, type of compound, etc.) (see **Physiology and Adaptability**) may account for the preferences in use between older versus younger Antelope-brush plants. Little is known about the potential role of Antelope-brush physio-chemicals in the butterfly's life cycle.

Further correlations from observations and inventory data suggest that Behr's Hairstreak adults may require sparse tree cover, particularly Ponderosa Pine, for shelter during inclement weather and daytime temperature extremes, as well as for night-time resting (S. Desjardins pers. comm. 2007 – 2009).

Behr's Hairstreak appears to require the presence of mud puddles (or other puddling sites) where adult butterflies obtain moisture and salt (D. St. John pers. comm. 2007; S. Desjardins pers. comm. 2007).

Habitat Trends

Since 1800, Antelope-brush grassland habitat has significantly declined in quantity and quality in the south Okanagan valley (Schluter *et al.* 1995; Lea 2001; Dyer and Lea 2002; Iverson *et al.* 2005; Lea 2008; Iverson 2010) (see **THREATS AND LIMITING FACTORS**). Table 4 summarizes losses for habitats relevant to Behr's Hairstreak over time.

Table 4. Plant community type, area of habitat loss, percent remaining (Iverson *et al.* 2005) and ownership (Iverson 2010).

Plant Community	Year 1800 (ha)	Year 2009 (ha)	% Remaining	Ownership (as of 2009)	Area (ha)	Behr's Hairstreak Records (as of 2009)	% of Behr's Hairstreak Records*
Antelope-brush/Needle-and-thread Grass	9863	3217	3.5	Canadian Wildlife Service	111	3607	79
			56.2	Indian Reserve	1808		
			6.4	Provincial Crown land (unprotected)	205		
			5.7	BC Parks & Protected Areas	184		
			20	Private Lands	642		
			8.3	Private Conservation Land	266		
Pine Antelope-brush	1667	823	49	Canadian Wildlife Service	72	810	18
				Indian Reserve	263		
				Provincial Crown land (unprotected)	129		
				BC Parks & Protected Areas	12		
				Private Lands	235		
				Private Conservation Land	112		
Wheatgrass-Selaginella	1909	1886	99	Canadian Wildlife Service	14	9	0
				Indian Reserve	1024		
				Provincial Crown land (unprotected)	226		
				BC Parks & Protected Areas	88		
				Private Lands	517		
				Private Conservation Land	17		
Total	13340	5926	44				

Note these totals include other records:

- Behr's Hairstreak records in plant communities that contain Antelope-brush but where Antelope-brush is not the representative shrub type for the community (29 observations or 1% of records)
- Behr's Hairstreak records in plant communities that are not currently mapped as containing Antelope-brush, including habitats that have been destroyed by development (historically had Antelope-brush), are road right of ways, have a minor unmappable component of Antelope-brush, may be GPS or mapping errors, etc. (128 observations or 3% of records)
- *Note Antelope-brush plants also grow in other plant communities not listed above.

The most recent status report on the Antelope-brush/Needle-and-thread Grass plant community shows a decline from 9863 ha in 1800 to 4376 ha in 1995 to 3217 ha in 2009, a loss of 67.4% of the original extent of this ecosystem (Iverson 2010). From 1995 – 2003, 1077 ha of Antelope-brush/Needle-and-thread Grass were lost to habitat conversion at an average rate of 134.6 ha/year (Iverson 2010). The rate of Antelope-brush habitat loss peaked at 220 ha per year over 2 years (2001 – 2003) (B. White pers. comm. 2010). From 2003 to 2008, only 82 ha of habitat were lost to development, at an average rate of 16.4 ha/year (Iverson 2010). Although habitat loss appears to have slowed, this may partially be due to slower economic growth in the region (O. Dyer pers. comm. 2010). Planned potential development of areas where this plant community occurs are dealt with in the information appended to the threats calculator; 383ha are slated for construction projects at present, suggesting that the annual rate could return to close to peak very soon.

Continuing trends in habitat conversion (natural habitat and/or agricultural areas) are highest in the vineyard industry. There are 710 vineyards in B.C. (both winery and independently owned). Over half are within the range of Behr's Hairstreak, representing 68.6% of the total acreage in the province used for grape production (Table 5) (B.C. Wine Institute 2008). Increasing development pressure on the remaining private land and unprotected provincial Crown areas is expected. From 2008 – 2012 the B.C. Wine Institute (2008) projects the largest percentage increases in agricultural grape production will include the Penticton-Naramata regions, with 323.9 ha of grape planting estimated in 2009, and an additional 283.4 ha projected for 2010. Not all planting will take place on Antelope-brush habitat (some will take place on existing agricultural areas), although it is unknown what proportion.

Table 5. Vineyard development within the range of Behr's Hairstreak.

Region	Number of Vineyards	Acres	Percent Total
Oliver	138	3,398.27	37.5%
Osoyoos	74	1,407.96	15.5%
Penticton-Naramata	145	863.46	9.5%
Okanagan Falls	32	549.61	6.1%
Total	389	6219.3	68.6%

Wildfires are a common and natural ecosystem process in the Okanagan valley. Yet in the past 150 years, fire suppression management practices minimized wildfires within the region. The result has been increased fuel loads and natural forest succession: the effects of fire are expected to be more severe than historical occurrences (Iverson 2010).

In 2003, the Okanagan valley experienced the most significant fires in recent history, with over 250 square kilometres (61,776 ha) affected (O. Dyer pers. comm. 2009). The total area of Antelope-brush plant communities affected by these (and more recent) fires has not been quantified and the impact on Behr's Hairstreak populations is unpredictable given the species' intermittent use of different habitat patches over time. Antelope-brush plants are typically killed by fire and those that survive do not re-sprout well (Zlatnik, 1999). One Behr's Hairstreak habitat patch within the Vaseux Bighorn National Wildlife Area that experienced fire in 2003 no longer appears to support a population (S. Hureau pers. comm. 2010). The butterfly was last recorded from this habitat patch in June 2004 but has not been seen since despite further surveys (S. Hureau pers. comm. 2007; O. Dyer pers. comm. 2009). The butterfly is still present within this same protected area, within Antelope-brush habitat that was not affected by these fires (O. Dyer pers. comm. 2009).

The impact of wildfire on Antelope-brush ecosystems at one location increases ecological pressure on other locations. For example, once forage sites are destroyed by fire, ungulates will increase grazing and browsing pressure on other parcels of habitat. Depending on the type and severity of the fire, further degradation can occur (e.g., organic components of the soil may be completely burned and trees burned entirely, including the roots, leaving only ash holes in the ground). If there is complete loss of vegetation, including seed banks, natural regeneration and succession must begin from mineral soil. The prospects for natural restoration to pre-fire conditions are doubtful given other threats and limiting factors.

In July 2009 a small fire occurred within an Antelope-brush habitat patch that contains one of the largest known populations of Behr's Hairstreak in B.C. (location 8 above the northern boundary of the Osoyoos Indian Reserve, Figure 9) (S. Desjardins pers. comm. 2009; O. Dyer pers. comm. 2009). The wildfire area was estimated at 10 – 12 ha and was not within the portion of the habitat patch that contains significant numbers of Behr's Hairstreak individuals (as suggested by the previous 4 years of surveying) (S. Desjardins pers. comm. 2009).

Antelope-brush plant communities contain numerous introduced species that are slowly changing the ecological characteristics of the habitat over a long period of time, through changes in soil chemistry and in the subsequent alterations of the invertebrate and plant communities. Fuel loads within Antelope-brush ecosystems have increased with the spread of non-native plants such as Cheatgrass (*Bromus tectorum*) and other invasive species. It is likely that accumulated plant detritus from these invasive plants changes the type, severity and duration of fire and eliminates potential native plant seed sources (Iverson *et al.* 2005). Introduced plants and animals are expected to cause negative impacts to Behr's Hairstreak (see **THREATS AND LIMITING FACTORS**).

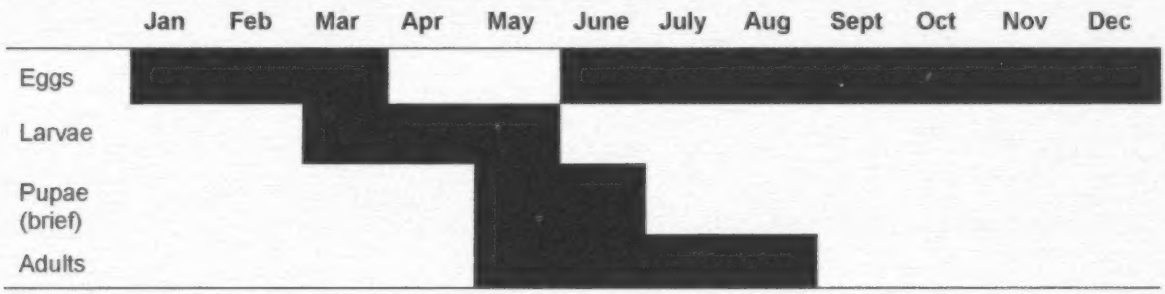
BIOLOGY

Life Cycle and Reproduction

Behr's Hairstreak is univoltine with a flight season in B.C. that occurs from mid-May through mid-August and peaks in mid- to late June depending on spring temperatures (COSEWIC 2000; Guppy and Shepard 2001; B.C. Conservation Data Centre 2009). Mating and oviposition coincide with the flight season. Male hairstreaks have scent scales located on the forewing that produce pheromones, and are used for attracting females (Guppy and Shepard 2001). Detailed demographic data are not available.

Eggs are laid singly and attached to the stem, twigs, leaves and branches of the only known larval host plant, Antelope-brush. Each plant hosts a single egg and not all plants are used in any one year; thus the number of plants cannot be taken as indicative of the size of the butterfly population (Fraser, personal communication, 2012). Eggs overwinter and hatch the following spring (Emmel and Emmel 1973). Pupation occurs in late spring, with the pupae attached to the stem or twigs of Antelope-brush by a silk patch (Guppy and Shepard 2001). The length of pupal development is unknown, although based on larval observations and adult flight period, is estimated at less than two weeks. Table 6 shows the temporal life cycle of Behr's Hairstreak.

Table 6. Yearly life cycle of Behr's Hairstreak (based on observations).



Hairstreaks typically have four or five larval development stages (instars) prior to pupation (Kitching *et al.* 1999) although the specific number of larval instars for Behr's Hairstreak in Canada is unknown.

Males have been observed perching on the tips of Antelope-brush or other plants, and sometimes on hilltops (Warren 2005).

Physiology and Adaptability

The chemical composition of Antelope-brush may have an influence on the ecology of Behr's Hairstreak based on the plant's chemical properties and importance to other vertebrate and invertebrate herbivores (Young and Clements 2002). Antelope-brush is known to produce a variety of secondary compounds including the cyanoglucosides pushianin and menisdaurin (Nakanishi *et al.,* 1994). Plant chemicals are often produced to reduce herbivory, but some butterflies have developed mechanisms to sequester plant chemicals to reduce predation, particularly of larvae (Roitberg and Isman 1992; Bernays and Chapman 1994). Plant chemicals may be important for reproduction by enhancing congregation or indicating oviposition sites (Honda *et al.* 1997). Differences in plant chemistry (e.g., concentration of compounds or type of compound) may also account for the preferences in use of older Antelope-brush plants over younger plants (see **Habitat Requirements**). The chemical and physiological role of different age stands of Antelope-brush in the butterfly's life cycle (aside from being a larval host plant) represents a significant knowledge gap.

Dispersal and Migration

Desjardins (pers. comm. 2009) documented average dispersal distances for Behr's Hairstreak in the south Okanagan Valley of 120 m in 2005 (during warm and dry spring weather) and 80 m in 2006 (cool and rainy spring weather). The maximum dispersal distance recorded (2004 – 2007) was from one recaptured adult (out of 2753 individuals marked over the four seasons and 696 recaptured) 1.2 km from its original mark site (S. Desjardins pers. comm. 2009). This dispersal distance was from the Vaseux Creek study area to Inkaneep Provincial Park and the intervening area includes Antelope-brush habitat patches. Preliminary results from this same study primarily show limited movement of individuals between habitat patches.

Tews *et al.* (2004) modelled Behr's Hairstreak dispersal capabilities and estimated the maximum dispersal distance at 1 km based on observations from similar-sized butterflies within structurally similar patchy habitat (see Baguette 2003). This is consistent with the maximum observed dispersal of 1.2 km.

At the Vaseux Lake study site, Behr's Hairstreak has been recorded in close proximity to Antelope-brush plants (S. Desjardins, pers. comm., 2009). Some individuals appear to disperse between Antelope-brush clumps within this study site, through habitat that appears suitable but where few butterflies are recorded. It is unknown what habitat component is lacking in the patches between the populations, but the butterfly does not colonize these areas (S. Desjardins pers. comm. 2009).

This species, like many small butterflies, does not disperse across areas of unsuitable habitat. As noted above, dispersal is limited even when areas between sites occupied by the butterfly are suitable. Currently known sites are separated by agricultural land, housing developments, roads and rivers. As even the largest known population has numbers that are sufficiently small to suggest that they may not be sustainable in the long term, it is difficult to avoid the conclusion that populations of this species are severely fragmented in Canada.

Interspecific Interactions

Antelope-brush supports a diverse insect community; Furniss (1972) listed 76 phytophagous insects, including 20 butterfly and moth species, for which the larvae are found on Antelope-brush in the western United States. Behr's Hairstreak is not known to have significant ecological roles such as forming a major part of food-web dynamics, although small mammals, invertebrate predators and birds likely prey upon the butterfly.

Mutualistic associations (termed myrmecophily) between Behr's Hairstreak and ants (Hymenoptera: Formicidae) may be important for supporting populations of the butterfly (Ballmer and Pratt 1991; Pierce *et al.* 2002). Based on studies from Behr's Hairstreak (*S. b. behrii*) populations in California, Ballmer and Pratt (1991) suggest the species' larvae are myrmecophilous; ants protect the larvae from parasites and parasitoids, and in return the larvae provide the ants with food (amino acids secreted from specialized glands) (Fraser *et al.* 2001, Pierce *et al.* 2002). Similar to many members of the Lycaenidae, Behr's Hairstreak larvae have specialized organs that secrete amino acids that attract ants (Ballmer and Pratt 1989). Ants help to create seed-caching mounds and unique plant communities (Young and Clements 2002) that may be of importance to Behr's Hairstreak. St. John and Bunge (2003) hypothesize that habitat quality may relate to the presence of specific ant species.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Little information is available on population size of Behr's Hairstreak in British Columbia. Although research is ongoing at Vaseux Creek study area, population estimates are not yet available (S. Desjardins pers. comm. 2012).

Richardson (pers. comm. 2009) used RAMAS GIS applications to model Behr's Hairstreak population viability in the south Okanagan and suggested that the results overall are not a good indication of population viability. This was because the results were dependent upon how habitat polygons were mapped, grouped, and analyzed (Richardson pers. comm. 2009). Richardson (pers. comm. 2009) does not believe the information is sufficient to guide management decisions nor determine long-term population viability with confidence. Data that could be used to extrapolate population trends from similar habitats in Washington or Oregon are not available.

Tews *et al.* (2004) also modelled the viability of Behr's Hairstreak populations in the portion of the species' range in Canada. The model was based on existing Antelope-brush plant community mapping and the assumption of a uniform carrying capacity of 100 adults per hectare of suitable habitat. The results suggest that Behr's Hairstreak will exhibit high population stability over 100 years, although the extinction risk at certain habitat patches increases with fire activity and with the loss of specific Antelope-brush habitat islands that likely improve dispersal (i.e., stepping-stone habitats). Results were compared with monitoring studies of the related subspecies, Cross's Hairstreak (*S. behrii crossi*), in New Mexico, which showed high interannual variation in local abundance (Fleishman *et al.* 2003). Variability in population occurrence and population size in Cross's Hairstreak suggests that climate factors, predation, disease, or unknown habitat factors may be more important than the presence of abundant larval-food plant resources. The assumptions used in this modelling are unrealistic (the butterfly does not occupy all habitat patches at equal density) and was performed in the absence of population estimate data, which indicate that even the largest population can fluctuate from over 3000 to less than 500 individuals in 12 months and the smaller population sizes found are below minimum viable population sizes.

Abundance

Population estimates using the Schnabel method (Schnabel 1938) made at the largest known population gave population peaks over the years 2004-2007 of 1200, 3000, 3200 and 450 respectively. These data suggest that even this population is unlikely to be viable in the long term.

Fluctuations and Trends

The data provided above are suggestive of considerable, though perhaps not extreme, population fluctuation.

Rescue Effect

Rescue effect from Behr's Hairstreak populations in Washington State (near the border town of Oroville) may be possible, provided there is connective habitat within dispersal distance. Behr's hairstreak has been documented in several Washington state locales just south of the British Columbia border, including "Oroville", "Molson-Chesaw Rd", and "Unnamed draw - 5 miles west of Oroville" (Hinchliff 1996). These sites are approximately 16km south of the closest Canadian population, which is at Haynes' Lease Ecological Reserve. There may be some connective patches of suitable Antelope-brush habitat adjacent to the Canada-United States border, according to aerial photograph interpretation (made through use of Google Earth 2009), although analysis has not been completed and there is no information on documented populations within these patches. Antelope-brush habitat loss is ongoing in the United States, and although Behr's Hairstreak is not considered at risk, state biologists are concerned about the species and plan to start inventory work (A. Potter pers. comm. 2009). Given the species' disinclination for moving through unsuitable habitat, rescue seems unlikely under natural circumstances.

THREATS AND LIMITING FACTORS

Threats to Behr's Hairstreak

The primary threat to Behr's Hairstreak is Antelope-brush plant community habitat loss, degradation, and fragmentation from development. Vineyards, grazing areas, and urban development are mutually exclusive land uses, and therefore cause cumulative losses to suitable habitat. Threats to Behr's Hairstreak populations and habitat have been discussed by the Southern Interior Invertebrates Recovery Team (2008).

At present, there are at least 26 separate parcels totalling at least 4057 ha of habitat under the Land Act Review process (Appendix 3) and potentially available for disposition. Most, if not all, of this land will ultimately be converted to rangeland (e.g., livestock grazing), residential, commercial or other agricultural development. Of these parcels, three parcels total 81 ha of habitat with Behr's Hairstreak recorded (including 5 ha with potential Behr's Hairstreak that has not been confirmed, but adjacent sites have records of the butterfly); 541.6 ha with confirmed Antelope-brush on the site (but no surveys for Behr's Hairstreak). The remainder of the parcels (approximately 3516 ha) have been assessed as "likely to contain Antelope-brush" but ground surveys need to be completed; 84.8 ha is to be protected (but has not been legally designated). Note the size of many of these sites is small (< 20ha) and fragmented with development in between.

The most important threats are as follows:

Housing, commercial/industrial development and land conversion to viticulture have impacted Behr's Hairstreak habitat in the past and more such activities are planned for the immediate future. These threats have an extreme impact upon butterfly numbers.

Livestock ranching is expected to impact a large number of locations but has a moderate scope because patches of the larval hostplant are expected to persist.

Fire likely kills all life stages that come into contact with it, but fire suppression causes the habitat to become unsuitable for the species over a longer time frame. Thus the scope for this threat was considered to have a wide range but the scope was restricted.

PROTECTION, STATUS, AND RANKS

Legal Protection and Status

Behr's Hairstreak is listed under the federal *Species at Risk Act* (SARA), which provides immediate protection for individuals and their residences on federal lands, and includes provisions for the protection of critical habitat once identified in a recovery strategy. As of April 2010, a residence description for Behr's Hairstreak has not been posted on the Public Registry. Similarly, a finalized recovery strategy has not yet been posted on SARA, and hence, critical habitat for the species has not yet been defined. A B.C. recovery strategy has been posted on the B.C. Recovery Planning Documents Table webpage and is available for adoption by the federal government and for subsequent posting on the SARA public registry (B.C. Ministry of Environment 2012). Behr's Hairstreak was included on Schedule 1 of SARA as threatened in 2003 when the Act was proclaimed. The species was previously assessed by the Committee on the Status of Endangered Wildlife in Canada as threatened in 2000 (COSEWIC 2000).

Behr's Hairstreak is protected within areas under the *Canada Wildlife Act*, respectively (e.g., previously occupied site at Vaseux Bighorn National Wildlife Area is within dispersal distance from other occupied sites). The B.C. *Park Act* protects invertebrate species at risk in provincial parks and protected areas, namely those with conservation status ranks designating the species to Red and Blue lists as posted by the B.C. Conservation Data Centre (2009). When species at risk and the habitats they require are known to occur within a protected area, provisions for management are incorporated into the park master plan (e.g., Inkaneep Provincial Park location). Further, the B.C. *Ecological Reserves Act* provides protection for species occurring within ecological reserves in B.C. Both federal lands managers and staff (S. Hureau pers. comm. 2003 – 2009) and provincial parks staff (S. Bunge pers. comm. 2003 – 2009) within the range of Behr's Hairstreak are aware of the habitat requirements for this species, will survey suitable Antelope-brush habitats throughout the flight season, and

are working to include the species within park planning and management. Non-government conservation organizations, such as the Nature Trust (C. MacNaughton pers. comm. 2009) and Osoyoos Desert Centre (Dyer pers. comm. 2009) incorporate protection measures for Behr's Hairstreak within the properties these organizations manage. Behr's Hairstreak is not known to occur within regional or municipal habitats, although these governments are aware of the species and its potential habitat (O. Dyer pers. comm. 2003 – 2009).

Behr's Hairstreak is recommended for listing as *Identified Wildlife* under the *B.C. Forest and Range Practices Act*. Once listed under this act, it will be possible to protect known sites and habitat for this species within Wildlife Habitat Areas on provincial Crown land.

Invertebrates listed by COSEWIC as *threatened, endangered* or *extirpated* will be protected through the British Columbia *Wildlife Act* and *Wildlife Amendment Act* once the regulations listing these species under provincial legislation are completed.

Behr's Hairstreak is noted in the Standards and Best Practices for Instream Works (B.C. Ministry of Water, Land and Air Protection 2004) as associated with dry riparian areas, although no specific management measures are provided. This document provides best management practices guidelines and information when planning and carrying out proposed development activities around riparian areas in the southern interior ecosystems.

The draft recovery strategy goal for Behr's Hairstreak (B.C. Southern Interior Invertebrates Recovery Team 2008) is to "maintain a viable, well-distributed population of Behr's Hairstreak in protected habitats within the known range in British Columbia". Protected habitat is "habitat managed to maintain Behr's Hairstreak over a long time period (i.e., 100 years). Management may involve protection in various forms, such as following best management practices for maintaining Behr's Hairstreak and its habitat, stewardship agreements, conservation covenants, eco-gifts or sale of private lands by willing landowners, land-use designations and management on Crown lands, and protection in federal, provincial, and local government protected areas. The recovery objectives for the species include protecting a minimum of 820 ha of Behr's Hairstreak habitat by 2013".

Non-Legal Status and Ranks

Behr's Hairstreak has a global heritage rank of G5 (secure) (NatureServe 2010) and Behr's Hairstreak *columbia* subspecies has a global heritage rank of G5T4T5 (NatureServe 2010). Other Behr's Hairstreak subspecies have not been assigned a global conservation status rank (NatureServe 2010). The national rank in Canada is N1N2 (critically imperiled/imperiled). In B.C., the species is ranked S1 (imperiled) (and is Red-listed, B.C. Conservation Data Centre 2012). Within the United States the species is designated N5 (secure) (NatureServe 2010). The species is SNR (not ranked) in Arizona, Idaho, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, and Wyoming; S5 (secure) in Colorado and Washington; and S4 (apparently secure) in California (NatureServe 2010).

Behr's Hairstreak is a priority one species (highest priority) under goal three (maintain the diversity of native species and ecosystems) of the B.C. Conservation Framework (see www.env.gov.bc.ca/conservationframework/).

Habitat Protection and Ownership

Antelope brush plant communities within the range of Behr's Hairstreak are under various forms of protection, ownership, and management. Indian Reserves contain 56.2% of the existing Antelope-brush habitat, 20% occurs on unprotected private land, 8.3% on private conservation land, 5.7% on provincial government protected areas, 6.4% on provincial Crown land (unprotected), and 3.5% is on federal government land (Canadian Wildlife Service) (Iverson 2010). The Indian Reserves and CWS lands fall under the jurisdiction of SARA. Thus, it is interesting to note that "The En'owkin Centre (Okanagan Indian Educational Resources Society) has embarked on a land-use planning and restoration project for First Nations Lands, which provide crucial habitat for many species at risk. Input will also be provided to recovery teams based on the work of Traditional Ecological Knowledge councils and traditional conservation practices" (SARA public registry).

More than 870 ha of Antelope-brush habitat within the range of Behr's Hairstreak in Canada has some form of protection (Appendix 3) (O. Dyer pers. comm. 2009; B. White pers. comm. 2009). The Nature Trust has protected 443 ha of Antelope-brush habitat; the B.C. government has protected 271 ha within the South Okanagan Wildlife Management Area and other protected areas; The Land Conservancy Peachcliff property is 16 ha total, but contains less than one hectare of Antelope-brush habitat (A. Skinner pers. comm. 2009). Additionally, the federal government has protected 243 ha in the Vaseux Bighorn National Wildlife Area. The Land Conservancy has also established stewardship agreements (written agreement, five-year term) on a four ha Antelope-brush habitat parcel in Okanagan Falls and another 0.4 ha parcel of Antelope-brush habitat at Tinhorn with the respective private landowners (A. Skinner pers. comm. 2009).

As of 2009 the B.C. government owns more than 560 ha of Antelope-brush plant community habitat (Appendix 3) (B. White pers. comm. 2009). Of this habitat, 303 ha are conservation lands, 61 ha are under consideration for Wildlife Management Areas, 46 ha are under consideration for Protected Areas, 15 ha are considered non-conservation tenures, and 163 ha comprise vacant Crown land with no protection (a portion of which is to be sold within the year (B. White pers. comm. 2010).

Conservation lands, combined, protect 15% of the existing Antelope-brush habitat in B.C. (Appendix 3), although this is only 6.5% of the historical habitat. Behr's Hairstreak populations are present in the following provincial and federal protected areas: Inkaneep Provincial Park, Haynes Lease Ecological Reserve, South Okanagan Wildlife Management Area (adjacent to Haynes Lease Ecological Reserve), Canadian Wildlife Service property, and Osoyoos Desert Centre (B.C. Conservation Data Centre 2009).

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

Thank you to the British Columbia Ministry of Environment for providing time and resources to complete this report. The following people provided valuable information, advice, and knowledge from their experiences in the field: Sylvie Desjardins, Dennis St. John, Orville Dyer, Bryn White, Howie Richardson, Ron Hall, Jeanette Armstrong, Stephen Hureau, Sara Bunge, Alyson Skinner, Lucy Reiss, Dawn Marks, Vicky Young, Daris Piper, Crispin Guppy, Norbert Kondla, Brenda Costanzo, Suzie Lavallee, Jerry Mitchell, and Nick Page. Thank you to Ann Potter (Washington Department of Fish and Wildlife) for information about Behr's Hairstreak in Washington State. Thank you to Orville Dyer for map preparation and document review. Thank you to Karen Needham (Spencer Entomological Collection at the Beaty Biodiversity Museum, University of British Columbia) for access to the collection.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Jennifer Heron is the provincial invertebrate specialist with the B.C. Ministry of Environment, Wildlife Science Section. She directs and manages the provincial approach to invertebrate conservation, including the development and implementation of provincial legislation, policy, procedures, and standards for the conservation and recovery of invertebrate species at risk, their habitats and ecosystems, and to keep these species from becoming at risk. She works with other invertebrate specialists to develop recovery-planning approaches and assign conservation status ranks to invertebrate groups. She works with local conservation and stewardship groups to achieve common public outreach goals.

COLLECTIONS EXAMINED

See Appendix 1

Appendix 1. List of Behr's Hairstreak Museum and Collection Records as summarized in COSEWIC (2000).

CNC: Canadian National Collection, Agriculture Canada, Ottawa; RBCM: Royal British Columbia Museum, Victoria; UBC: Beaty Biodiversity Museum, Spencer Entomological Collection, University of British Columbia, Vancouver; AMNH: American Museum of Natural History, New York; JHS: Jon Shepard, Nelson; CSG: Crispin Guppy, Quesnel; NK: Norbert Kondla, Calgary, AB; CAS: California Academy of Sciences, San Francisco; DT: David Threatful, Vernon. Specimen numbers in square brackets refer to either sight records or specimens not confirmed or sexed by the author.

Location	Elevation	Year	Month	Day	Collector	Collection	Male	Female
Anarchist Mt.	1000'	1976	7	4	J. and S. Shepard	CSG	3	1
Fairview [Oliver]		1919	6	12	W. B. Anderson	UBC	1	0
Fairview [Oliver]	1500'	1996	7	1	C. S. Guppy	CSG	1	0
Fairview/White L. Rd.		1995	6	15	R. D. St. John		[1]	0
Inkaneep Provincial Park		1995	6	9	R. D. St. John		[1]	0
Jct. Hwy. 3A/97		1995	6	25	R. D. St. John		[1]	0
McIntyre Bluff		1995	6		R. D. St. John		[1]	0
McLean Cr.		1995	6	21	R. D. St. John		[1]	0
Mld. [Osoyoos]		1898	5	24	E. M. A[nderson].	RBCM	0	1
Mld. [Osoyoos]		1901	6	29	E. Anderson	RBCM	[1]	0
Mld. [Osoyoos]		1901	6	29	E. M. A[nderson].	RBCM	1	0
Okanagan Falls		1995	6	21	R. D. St. John		[1]	0
Okanagan Falls			6	21	C. Garrett	AMNH	0	1
Oliver		1953	7	23	J. R. McGillis	CNC	0	1
Osoyoos		1895	7	23		CNC	0	1
Osoyoos		1919	6	10	W. B. Anderson	CNC	1	1
Osoyoos		1919	6	10	W. B. Anderson	UBC	1	0
Osoyoos		1919	6	12	W. B. Anderson	CNC	1	0
Osoyoos		1919	6	12	W. B. Anderson	CNC	1	0
Osoyoos Lake	1000'	1996	6	30	C. S. Guppy	CSG	4	5
Osoyoos, 2mSE	1000'	1976	7	4	J. and S. Shepard	JHS	10	0
Oliver, 5 km N		1999	6	17	D. Threatful	NK	46	6
Penticton Dist.			6	10	Blackmore Coll.	UBC	1	0
Sigalet Rd, Mabel L.	3000'	1969	6	16	PRE	AMNH	1	0
Vase[a]ux L.		1972	6	18	D. L. Threatful	DT	[1]	0
Vase[a]ux L., W		1995	6	15	R. D. St. John		[1]	0
Veronica/Hwy. 3		1995	6	28	R. D. St. John		[1]	0

Appendix 2. Land Act Review - provincial Crown land identified for potential sale or disposition (B. White pers. comm. 2011; A. Haney pers. data 2011).

Parcel Number	Parcel Size (ha)	Biodiversity Conservation Strategy* Relative Conservation Value	Notes on land parcel (air photo analysis and surveys). Unless stated, parcel is potentially for sale or disposal to private sector.
23	567 ha in 5 parcels	High	Possible Antelope-brush sites. Requires surveys for species at risk.
26	13.4	Moderate to high	Possible Antelope-brush sites. Requires surveys for species at risk.
36 - 1	5.4	High	Antelope-brush sites throughout. Requires surveys for species at risk. On the list of properties for immediate sale to the private sector.
38	3.3	Very High (important east-west corridor linkage)	Confirmed Antelope-brush sites. Requires additional surveys for species at risk. Negotiations in progress to allow for disposal of this parcel. Province has issued the Osoyoos Indian Band a licence of occupation. Parcel is to be developed to vineyard (Min of Transportation also involved).
40	152	Not yet assessed	Requires surveys for species at risk.
44.2	2.6	Very High	Confirmed Antelope-brush sites. Requires additional surveys for species at risk.
44.3	8.3	Not yet assessed	Requires surveys for species at risk.
44.4	27.7	High (pending field assessment).	Possible Antelope-brush sites Requires surveys for species at risk.
44.5	4.5	High	Possible Antelope-brush sites. Requires surveys for species at risk.
44.6	18.8	High	Confirmed Antelope-brush sites throughout. Requires surveys for species at risk.
44.7	2336	Not yet fully assessed	Possible Antelope-brush sites. Requires surveys for species at risk.
51	37.3	Very High	Not likely to be for immediate sale or disposal although still listed as potential sale or disposal. Confirmed Antelope-brush sites throughout. Former Fairview town site (near Oliver). Very valuable ecologically—abundant Antelope-brush throughout site. There is currently a licence on a small portion of the property for historical purposes (interpretive trail). There is an understanding from the Land and Resource Management Plan (for the south Okanagan) that if the site is not used for historical purposes (e.g., the licence is revoked due to lack of use) or that any remainder of the site is available for disposal then the property is to be incorporated into the Oliver Mountain Goal 2 site (proposed provincial park). The Town of Oliver has suggested the property be used for development.
68.2	40.6	High	Confirmed Antelope-brush sites throughout. Requires surveys for species at risk. Big Sagebrush-Blue Bunchgrass Not likely to be for immediate sale or disposal although still listed as potential sale or disposal. Proposed Wildlife Habitat Area (protected under the *Forest and Range Practices Act*).

Parcel Number	Parcel Size (ha)	Biodiversity Conservation Strategy* Relative Conservation Value	Notes on land parcel (air photo analysis and surveys). Unless stated, parcel is potentially for sale or disposal to private sector.
68.3	5.5	Not yet fully assessed.	Confirmed Antelope-brush sites throughout. Requires surveys for species at risk.
68.5	10.2	Very High (important east-west corridor linkage between ecological reserve and Osoyoos Desert Centre conservation area)	Confirmed Antelope-brush sites throughout. Requires additional surveys for species at risk. Behr's Hairstreak has been confirmed at this site and adjacent protected property. Provides a north-south and east-west corridor between Field's Lease Ecological Reserve (provincial) and the Osoyoos Desert Centre.
68.6	5 (un-confirmed)	High to Very High	Confirmed Antelope-brush sites throughout. Requires additional surveys for species at risk. Work in progress to allow for disposal of this parcel (and a portion of the Crown land north of it). A commitment has been made to the Osoyoos Indian Band to sell them this parcel. Parcel also contains a "right of way" for a reservoir for Town of Osoyoos. Behr's Hairstreak recorded from adjacent areas.
69	65.8	High	Behr's Hairstreak recorded from the area.
70	19.8	Moderate to High	Confirmed Antelope-brush sites Requires additional surveys for species at risk.
78	344.7	Very High	Confirmed Antelope-brush sites throughout. 15 red-listed and 13 blue-listed species recorded from this parcel. 3 rare invertebrate species, including 2 species of scorpions. Need additional butterfly surveys.
109	380	Very High	Possible Antelope-brush sites throughout. Requires additional surveys for species at risk.
125		Not yet assessed.	Possible Antelope-brush sites throughout. Requires additional surveys for species at risk. The former lower reaches of Tinhorn Creek. The creek no longer runs through the property because Tinhorn diverts the water upstream (via a dam) for irrigation. In addition, the creek also has a water licence for grazing. The riparian area is under constant drought but does retain grassland values.
140 and 140.1	2.6 (trespass area only)	High in non-trespass areas	Testalinden Creek. This parcel contains trespasses onto Crown land. Consider legalizing trespasses only within the trespass parcel (remainder of area should be combined with 140.1). Good condition antelope brush habitat except in trespass areas. Requires additional surveys for species at risk.
140.2	6.9	High	Not likely to be for immediate sale or disposal although still listed as potential sale or disposal by Land Act Review. To be protected as Section 16 preserve. Confirmed Antelope-brush sites. Requires additional surveys for species at risk.
145	Not yet assessed.	High	Confirmed Antelope-brush sites throughout. Requires additional surveys for species at risk although species at risk have been recorded from the site. Located just north of Oliver and flanks the Oliver Mountain Goal 2 Site (proposed provincial park). The potential disposition of this site is of high concern.

Parcel Number	Parcel Size (ha)	Biodiversity Conservation Strategy* Relative Conservation Value	Notes on land parcel (air photo analysis and surveys). Unless stated, parcel is potentially for sale or disposal to private sector.
153	2.2	Not yet assessed	Designated for sale This parcel along with its neighbour (LAR 55) was the subject of much controversy in the last few years. The Town of Oliver sought a municipal boundary amendment (taking lands out of the regional district). Subsequent rezoning then allowed for industrial uses to the north of the site. This created an island for species (now mostly located on parcel 55 and 153). The airphoto on the map is somewhat dated as the land to the north is now all industrial park.
Total (approximate)	26 sites ranging in size from 2.2 ha to 2336 ha. 14 sites under 20 ha. 4057.4 ha (approx) total available for sale or disposition. 541.6 ha with confirmed Antelope-brush sites. Remainder of property has been assessed as "likely to contain Antelope-brush" but ground surveys need to be completed. 81 ha with Behr's Hairstreak recorded (includes 5 ha with potential Behr's Hairstreak that has not been confirmed, but adjacent sites have records of the butterfly). 84.8 ha to be protected (but has not been legally designated). Note the size of many of these sites is small (< 20ha) and fragmented with development in between.		